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TITLE: Symmetrical Multi-Unit Railroad Car

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I,

Mohamed Al-Kaabi of 152 Redfern Avenue, Hamilton, Ontario L7S 2L8; and

Jamal Hematian of 1272 Ontario Street, Unit 203, Burlington, Ontario, L7S 2L8

have invented a : **SYMMETRICAL MULTI-UNIT RAILROAD CAR**

of which the following is a specification.

SYMMETRICAL MULTI-UNIT RAILROAD CAR

FIELD OF THE INVENTION

[0001] This invention relates to multi-unit rail road cars, and in particular to symmetrical arrangements in such cars.

BACKGROUND OF THE INVENTION

[0002] Articulated multi-unit rail road cars typically have at least two railcar units permanently joined to each other end-to-end at an articulation connection. Most commonly, the adjoining railcar units share a truck, with the articulated connector being mounted over the truck center. In a conventional three-unit articulated rail road car, an intermediate, or middle railcar unit, may typically share a truck with each end railcar unit. The ends of the intermediate railcar unit are joined to the respective adjacent ends of the end railcar units by articulated connectors. A typical articulated connector includes a female articulated connector portion, or socket, mounted to one railcar unit; and an opposing mating male articulated connector portion, or member, mounted to the next adjacent railcar unit. Conventionally, the intermediate railcar unit in a three-unit rail road car is provided with an asymmetric arrangement of articulated connector portions, that is, it has a female articulated connector portion at one end and a male articulated connector portion at the opposite end. Correspondingly, the end railcar units have counterpart male or female articulated connector portions, as the case may be. In that style of layout, all female articulated connector portions extend toward the same end of the three-unit rail road car.

[0003] In order to control "side sway", or roll, of one railcar unit relative to the next adjacent railcar unit, at each end having an articulated connector each railcar unit has a pair of side-bearing support arms. In one arrangement, at one end of the intermediate railcar unit, a narrow pair of side-bearing arms is nested within an opposing, relatively wider pair of side-bearing arms mounted to the adjacent end railcar unit. The side-bearing arrangement is reversed at the other end of the intermediate railcar unit such that the latter is provided with the wide pair of side-bearing arms and the adjacent end railcar unit has the narrow pair of side-bearing arms.

[0004] The ride characteristics in a conventional three-unit rail road car may tend to vary depending on the direction of travel. More specifically, it appears that the car may tend to perform "better" in one direction of travel than in the other, particularly when the car is running over curved portions of track. It has further been noted that the wheels of the shared

trucks may tend to be subject to greater lateral forces when the car is travelling in the direction associated with less satisfactory performance. It is thought that in addition to causing uneven wear on the truck wheels, this may also tend to increase the likelihood that the wheels will ride up on the rail, and jump the track.

[0005] The propensity of the wheels to ride up on the rail may be considered to be a function of the L/V ratio, where L is the lateral force to which the truck wheels are subject and V is the vertical force carried by the truck wheels. The higher the L/V value, the greater may be the likelihood that the truck wheels may tend to ride against the rail when the car negotiates a curve in the track. Accordingly, lower L/V values for the truck wheels may tend generally to be desirable. However, in a conventional rail road car of the type described above, under certain circumstances, the L/V values for the truck wheels may be significantly greater in one direction than the other. This may tend adversely to affect the stability of the car and may tend to generate undesirable vibration throughout the car structure. This in turn may ultimately lead to crack propagation and failure in the car, and consequently to costly car maintenance and repair. In addition, when travelling over a curved portion of track, the side-bearing arms in some of these cars may be subject to undesirably high forces further encouraging vibration in the car structure.

[0006] The difference in dynamic performance of the rail road cars may tend to be more (or less) pronounced depending on variation of the frequency of the input perturbances. That is, performance may tend to be a function of frequency and evaluation of the various alternatives may require optimization over the full range of forcing frequencies associated with in-service operation. It has been noted above that dynamic performance may be "better" in one direction than another. The term "better" needs to be understood in the expected operational life. An arrangement that may provide very good performance at one frequency, may provide very poor performance at another, such that, overall, it may be inferior to another layout that produces moderately good performance across the spectrum. In that context, the assessment of "better", is an overall evaluation performance.

[0007] The disadvantages associated with the conventional asymmetric three-unit articulated connector and side bearing arm arrangements noted above may not be restricted to three-unit cars. Other multi-unit articulated rail road cars having a larger number of rail car units may also tend to demonstrate similar dynamic performance phenomena.

[0008] Accordingly, in the view of the present inventors, it may be advantageous to construct a multi-unit articulated railroad car having a tendency to exhibit similar ride performance characteristics in both travel directions. Such a car may tend to be less prone to the development of fatigue cracks and may have an extended service life. It would also be desirable to have a multi-unit articulated railroad car in which the forces in the side-bearing arms are reduced to yield improved ride stability of the railroad car.

[0009] In a conventional multi-unit articulated rail road car, a number of different sub-assemblies are required to construct any given unit of the car. Manufacturing may be facilitated and made more cost-effective if the number of different sub-assemblies used in a given unit were reduced.

SUMMARY OF THE INVENTION

[0010] In an aspect of the invention, there is a multi-unit articulated railroad car comprising an un-even number of rail car units connected in end-to-end fashion by articulated connectors mounted above railroad trucks. The railroad car has a transverse centreline. The articulated connectors is mounted to the railcar units in a symmetrical arrangement relative to the transverse centreline.

[0011] In an additional feature of that aspect of the invention, one of the rail car units is a middle rail car unit. Each articulated connector has a male portion and a female portion. The middle rail car unit has two said male portions mounted thereto.

[0012] In another feature of that aspect of the invention, one of the rail car units is a middle rail car unit. Each articulated connector has a male part and a female portion. The middle rail car unit has two of said female parties mounted thereto.

[0013] In yet another feature, the railroad car has side bearing arms, and the side bearing arms are mounted in a symmetrical arrangement relative to the transverse centreline. In still another feature, one of the railcar units is a middle rail car unit carried between first and second areas of the rail car trucks. The middle rail car has side bearing arms mounted thereto. The side bearing arms engage bearing surfaces supported on the first and second trucks. The side bearing arms are arranged symmetrically relative to the transverse centerline. In a further still feature, at least one of the rail car units has a well defined therein for accommodating intermodal cargo.

[0014] In another aspect of the invention, there is a multi-unit articulated intermodal railroad car comprising first, second and third rail car units carried on a plurality of rail car

trucks. The first rail car unit is joined to the second rail car unit at a first articulated connection mounted to a first of the trucks. The second rail car unit is joined to the third rail car unit at a second articulated connection mounted to a second of the trucks. Each articulated connection has a male articulated connector portion associated with the end of one rail car unit and a mating female articulated connector portion associated with the end of an adjacent rail car unit. The second rail car unit has a first end adjacent the first rail car unit and a second end adjacent the third rail car unit. The first and second ends each have one of the male and female articulated connector portions mounted thereto. The articulated connector portion mounted to the first end of the second rail car unit is identical to the articulated connector portion mounted to the second end thereof. The first and third rail car units each have an end adjacent the second rail car unit. The first and third rail car unit ends each have the other of the male and female articulated connector portions mounted thereto for mating with the articulated connector portions of the first and second ends of the second rail car unit. The articulated connector portion mounted to the first rail car unit end is identical to the articulated connector portion mounted to the third rail car unit end.

[0015] In an additional feature of that aspect of the invention, the articulated connector portion mounted to each end of the second rail car unit is a female articulated connector portion. The articulated connector portions mounted to the first and third rail car unit ends are male articulated connector portions.

[0016] In an another feature, the articulated connector portion mounted to each end of the second rail car unit is a male articulated connector portion. The articulated connector portion mounted to the first and third rail car unit ends are female articulated connector portions.

[0017] In an additional feature, the second rail car unit includes a first pair of side bearing arms mounted to the first end thereof and a second pair of side bearing arms mounted to the second end thereof. The side bearing arms of the first pair are identical to the side bearing arms of the second pair. The first rail car unit end has a third pair of side-bearing arms mounted thereto for locating opposite the first pair of side-bearing arms. The third rail car unit end has a fourth pair of side-bearing arms mounted thereto for locating opposite the second pair of side-bearing arms. The side-bearing arms of the fourth pair are identical to the side-bearing arms of the third pair.

[0018] In a further additional feature, each side-bearing arm has a proximal end connected to a respective end of a rail car unit and a distal end. The side-bearing arms of the first pair are spaced away from each other a first distance measured center-to-center at the

proximal ends thereof. The side-bearing arms of the second pair are spaced away from each other a second distance measured center-to-center at the proximal ends thereof. The second distance is equal to the first distance. The side-bearing arms of the third pair are spaced away from each other a third distance measured center-to-center at the proximal ends thereof. The side-bearing arms of the fourth pair are spaced away from each other a fourth distance measured center-to-center at the proximal ends thereof. The fourth distance is equal to the third distance. In a further still additional feature, the third distance is greater than the first distance.

[0019] In an additional feature, the first pair of side-bearing arms is nested within the third pair of side-bearing arms. The second pair of side-bearing arms is nested within the fourth pair of side-bearing arms. In an another additional feature, the first pair of side-bearing arms lies laterally inboard of the third pair of side-bearing arms and the second pair of side-bearing arms lies laterally inboard of the fourth pair of side-bearing arms. In a further additional feature, the side-bearing arms of the first pair extend away from the first end of the second rail car unit in a mutually diverging manner and the side-bearing arms of the third pair extend away from the third rail car unit end in a mutually diverging manner.

[0020] In yet another additional feature, the first pair of side-bearing arms lies between the third pair of side-bearing arms and the second pair of side-bearing arms lies between the fourth pair of side-bearing arms. In a further feature, the third distance is less than or equal to about 70 inches. The first distance is at least about 42 inches. In another additional feature, the third distance is 60 inches and the first distance is 42 inches. In still another additional feature, the third distance is 52 inches and the first distance is 48 inches.

[0021] In another additional feature, the side-bearing arms of the first pair extend substantially perpendicular to the first end of the second rail car unit. The side-bearing arms of the third pair extend away from the third rail car unit end in a mutually diverging manner.

[0022] In another feature, the first distance is greater than the third distance. In an additional feature, the third pair of side-bearing arms is nested within the first pair of side-bearing arms. The fourth pair of side-bearing arms is nested within the second pair of side-bearing arms. In yet another additional feature, the third pair of side-bearing arms lies laterally inboard of the first pair of side-bearing arms. The fourth pair of side-bearing arms lies laterally inboard of the second pair of side-bearing arms. In a further feature, the side-bearing arms of the first pair extend away from the first end of the second rail car unit in a mutually diverging manner. The side-bearing arms of the third pair extend away from the third rail car unit end in a mutually diverging manner.

[0023] In another additional feature, the third pair of side-bearing arms lies between the first pair of side-bearing arms. The fourth pair of side-bearing arms lies between the second pair of side-bearing arms. In a further feature, the first distance is less than or equal to about 70 inches and the third distance is at least 42 inches. In still a further feature, the first distance is 60 inches and the third distance is 42 inches. In yet an additional feature, the first distance is 52 inches and the third distance is 48 inches.

[0024] In another additional feature, the side-bearing arms of the third pair extend substantially perpendicular to the third rail car unit end. The side-bearing arms of the first pair extend away from the first end of the second rail car unit in a mutually diverging manner.

[0025] In yet another additional feature, the first distance is equal to the third distance. In a further feature, the side-bearing arms of the first pair extend substantially perpendicular to the first end of the second rail car unit. The side-bearing arms of the second pair extend substantially perpendicular to the second end of the second rail car unit. The side-bearing arms of the third pair extend substantially perpendicular to the third rail car unit end. The side-bearing arms of the fourth pair extend substantially perpendicular to the fourth rail car unit end. In an additional feature, the distal ends of the side-bearing arms of the first pair are aligned with the distal ends of the third pair of side-bearing arms. The distal ends of the side-bearing arms of the second pair are aligned with the distal ends of the fourth pair of side-bearing arms. In yet another additional feature, the first distance is in the range of about 50 inches to about 70 inches. In still another additional feature, the first distance is 50 inches. In a further feature, the first distance is 70 inches.

[0026] In another feature, the side-bearing arms of the first and third pairs are mutually engaging. The side-bearing arms of the first pair has an upwardly facing bearing surface. The side-bearing arms of the third pair has a downwardly facing bearing surface.

[0027] In yet another feature, the side-bearing arms of the first and third pairs are mutually engaging. The side-bearing arms of the first pair has a downwardly facing bearing surface. The side-bearing arms of the third pair has an upwardly facing bearing surface.

[0028] In an additional feature, each articulated connection is carried at a first height above TOR. The side-bearing arms of each pair are carried at a second height above TOR. In a further feature, the second height is greater than the first height. In yet a further feature, the second height is 37 inches above TOR. In another feature, the second height is 44 inches above TOR. In yet another feature, the second height is substantially equal to the first height.

[0029] In yet another aspect of the invention, there is a multi-unit articulated intermodal railroad car comprising first, second, third, fourth and fifth rail car units carried on a plurality of rail car trucks. The first rail car unit is joined to the second rail car unit at a first articulated connection. The second rail car unit is joined to the third rail car unit at a second articulated connection. The third rail car unit is joined to the fourth rail car unit at a third articulated connection. The fourth rail car unit is joined to the fifth rail car unit at a fourth articulated connection. Each articulated connection having a male articulated connector portion associated with the end of a rail car unit and a mating female articulated connector portion associated with the end of an adjacent rail car unit. The first rail car unit has an end adjacent the second rail car unit. The first rail car unit end has one of the male and female articulated connector portions mounted thereto. The fifth rail car unit has an end adjacent the fourth rail car unit. The fifth rail car unit end has one of the male and female articulated connector portions mounted thereto. The articulated connector portion of the fifth rail car unit end is identical to the articulated connector portion of the first rail car unit end. The third rail car unit has a first end adjacent the second rail car unit and a second end adjacent the fourth rail car unit. The first and second ends each have one of the male and female articulated connector portions mounted thereto. The articulated connector portion mounted to the first end of the third rail car unit is identical to the articulated connector portion mounted to the second end thereof.

[0030] In an additional feature, the articulated connector portion mounted to each end of the third rail car unit is a female articulated connector portion. In a further feature, the articulated connector portions mounted to the first and fifth rail car unit ends are male articulated connector portions. In still another feature, the articulated connector portions mounted to the first and fifth rail car unit ends are female articulated connector portions.

[0031] In another additional feature, the articulated connector portion mounted to each end of the third rail car unit is a male articulated connector portion. In a further feature, the articulated connector portions mounted to the first and fifth rail car unit ends are female articulated connector portions. In another feature, the articulated connector portions mounted to the first and fifth rail car unit ends are male articulated connector portions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The present invention may be further understood by reference to the following detailed description of the embodiments of the invention, taken in conjunction with the accompanying drawings, in which:

[0033] Figure **1** is a side view of an example of a preferred embodiment of a three-unit articulated rail road car according to an aspect of the present invention, the illustrations of the units being foreshortened by the omission of sections as indicated;

[0034] Figure **2** is a top view of the three-unit articulated rail road car of Figure **1** showing an intermediate unit of the rail road car having a female articulated connector portion at either end thereof;

[0035] Figure **3** is an enlarged side view of a portion of the three-unit articulated rail road car of Figure **1**, showing an articulated connection between an intermediate unit and an adjacent end unit;

[0036] Figure **4a** is a schematic top view of the three-unit articulated rail road car of Figure **2**;

[0037] Figure **4b** is a top view of the portion of the three-unit articulated rail road car of Figure **3** showing a pair of side bearing arms of the intermediate unit nested within a pair of side bearing arms of an adjacent end unit;

[0038] Figure **5** is a cross-section of an illustrative articulated connector suitable for use with the three-unit articulated rail road car of Figure **1**, with the underlying shared truck thereof omitted from the illustration for clarity;

[0039] Figure **6** is a top view of an alternate embodiment of three-unit articulated rail road car to that of Figure **2** showing an intermediate unit of the rail road car having a male articulated connector portion at either end thereof;

[0040] Figure **7a** is a top view of a portion of a three-unit articulated rail road car showing a first alternative arrangement of side bearing arms to that shown in Figure **4a**;

[0041] Figure **7b** is a top view of a portion of a three-unit articulated rail road car showing a second alternative arrangement of side bearing arms to that shown in Figure **4a**;

[0042] Figure **7c** is a top view of a portion of a three-unit articulated rail road car showing a third alternative arrangement of side bearing arms to that shown in Figure **4a**;

[0043] Figure **7d** is a top view of a portion of a three-unit articulated rail road car showing a fourth alternative arrangement of side bearing arms to that shown in Figure **4a**;

[0044] Figure **7e** is a top view of a portion of a three-unit articulated rail road car showing a fifth alternative arrangement of side bearing arms to that shown in Figure **4a**;

[0045] Figure **7f** is a side view of the portion of the three-unit articulated rail road car shown in Figure **7e**;

[0046] Figure **8a** is a side view of an example of an embodiment of a five-unit articulated rail road car according to an aspect of the present invention;

[0047] Figure **8b** is a top view of the five-unit articulated rail road car of Figure **8a**;

[0048] Figure **8c** is a schematic top view of the five-unit articulated rail road car of Figure **8b**;

[0049] Figure **9a** is a schematic top view of a five-unit articulated rail road car showing a first alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0050] Figure **9b** is a schematic top view of a five-unit articulated rail road car showing a second alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0051] Figure **9c** is a schematic top view of a five-unit articulated rail road car showing a third alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0052] Figure **9d** is a schematic top view of a five-unit articulated rail road car showing a fourth alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0053] Figure **9e** is a schematic top view of a five-unit articulated rail road car showing a fifth alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0054] Figure **9f** is a schematic top view of a five-unit articulated rail road car showing a sixth alternative arrangement of side bearing arms to that shown in Figure **8c**;

[0055] Figure **10a** is a top view of an alternative embodiment of the five-unit articulated rail road car shown in Figure **8b**;

[0056] Figure **10b** is a schematic top view of the five-unit articulated rail road car shown in Figure **10a**;

[0057] Figure **10c** is a schematic top view of a five-unit articulated rail road car showing a first alternative arrangement of side bearing arms to that shown in Figure **10b**;

[0058] Figure **10d** is a schematic top view of a five-unit articulated rail road car showing a second alternative arrangement of side bearing arms to that shown in Figure **10b**;

[0059] Figure **10e** is a schematic top view of a five-unit articulated rail road car showing a third alternative arrangement of side bearing arms to that shown in Figure **10b**;

[0060] Figure **10f** is a schematic top view of a five-unit articulated rail road car showing a fourth alternative arrangement of side bearing arms to that shown in Figure **10b**;

[0061] Figure **10g** is a schematic top view of a five-unit articulated rail road car showing a fifth alternative arrangement of side bearing arms to that shown in Figure **10b**;

[0062] Figure **10h** is a schematic top view of a five-unit articulated rail road car showing a sixth alternative arrangement of side bearing arms to that shown in Figure **10a**;

[0063] Figure **11a** is a top view of a further alternative embodiment of the five-unit articulated rail road car in Figure **8b**;

[0064] Figure **11b** is a schematic top view of the five-unit articulated rail road car shown in Figure **11a**;

[0065] Figure **11c** is a schematic top view of a five-unit articulated rail road car showing a first alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0066] Figure **11d** is a schematic top view of a five-unit articulated rail road car showing a second alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0067] Figure **11e** is a schematic top view of a five-unit articulated rail road car showing a third alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0068] Figure **11f** is a schematic top view of a five-unit articulated rail road car showing a fourth alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0069] Figure **11g** is a schematic top view of a five-unit articulated rail road car showing a fifth alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0070] Figure **11h** is a schematic top view of a five-unit articulated rail road car showing a sixth alternative arrangement of side bearing arms to that shown in Figure **11b**;

[0071] Figure **12a** is a top view of an additional alternative embodiment of the five-unit articulated rail road car in Figure **8b**;

[0072] Figure **12b** is a schematic top view of the five-unit articulated rail road car shown in Figure **12a**;

[0073] Figure **12c** is a schematic top view of a five-unit articulated rail road car showing a first alternative arrangement of side bearing arms to that shown in Figure **12b**;

[0074] Figure **12d** is a schematic top view of a five-unit articulated rail road car showing a second alternative arrangement of side bearing arms to that shown in Figure **12b**;

[0075] Figure **12e** is a schematic top view of a five-unit articulated rail road car showing a third alternative arrangement of side bearing arms to that shown in Figure **12b**;

[0076] Figure **12f** is a schematic top view of a five-unit articulated rail road car showing a fourth alternative arrangement of side bearing arms to that shown in Figure **12b**;

[0077] Figure **12g** is a schematic top view of a five-unit articulated rail road car showing a fifth alternative arrangement of side bearing arms to that shown in Figure **12b**; and

[0078] Figure **12h** is a schematic top view of a five-unit articulated rail road car showing a sixth alternative arrangement of side bearing arms to that shown in Figure **12b**.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0079] The description which follows, and the embodiments described therein, are provided by way of illustration of an example, or examples of particular embodiments of principles and aspects of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description that follows, like parts are marked throughout the specification and the drawings with the same respective reference numerals.

[0080] In terms of general orientation and directional nomenclature, for each of the rail road cars described herein, the longitudinal direction is defined as being coincident with the rolling direction of the car, or car unit, when located on tangent (that is, straight) track. In the case of a car having a center sill, whether a through center sill or stub center sill, the longitudinal direction is parallel to the center sill, and parallel to the side sills, if any. Unless otherwise noted, vertical, upward and downward, are terms that use top of rail **TOR** as a datum. Unless otherwise noted, the term lateral, or laterally outboard, or transverse refers to

a cross-wise distance or orientation relative to the longitudinal centerline of the rail road car, or car unit, indicated as **CL - Rail Car**. The term "longitudinally inboard", or "longitudinally outboard" is a lengthwise distance taken relative to a mid-span lateral section of the car, or car unit.

Three-Unit Articulated Rail Road Car

[0081] A three-unit articulated rail road car is indicated in Figures **1** and **2** generally as **20**. Car **20** is preferably a freight car in the nature of an intermodal freight car, such as a COFC or TOFC flat car, or a spine car, or most preferably a well car, but could be another type of rail road freight car, such as an auto-rack car, a gondola car, a center-beam car, a box car, or other type of rail road car. It has a first rail car end unit **22**, an intermediate, or middle, rail car unit **24** and a second rail car end unit **26**, arranged end-to-end. Car **20** is carried on shared trucks **28** and **30**, and end car trucks **32** and **34**. End units **22** and **26** are each joined to intermediate unit **24** at an articulated connection **36** or **38**, as the case may be. Articulated connections **36** and **38** are mounted directly over shared trucks **28** and **30**, respectively. That is, the centre line of the articulated connection is co-incident with the truck centre.

[0082] Referring to Figure **3**, each shared truck **28** and **30** is a double axle, swivelling, three piece truck of customary North American layout and construction. Truck **28** (or **30**) includes a horizontal, transversely oriented truck bolster **40** supported on springs **42**, and a pair of side frames **44** mounted to the laterally outboard ends of truck bolster **40**. Side frames **44** carry a pair of longitudinally spaced apart axles **45** and **46** upon which are mounted wheel pairs **47**. Located atop truck bolster **40** is a truck center plate **48**. Truck center plate **48** supports the articulated connection **36** (or **38**) associated with two adjacent rail car units. Truck center plate **48** permits shared truck **28** or **30** to pivot, or swivel, about a generally vertical truck turning axis **50** namely the truck centre (as shown in Figure **3**) to follow the rails on the track. While in the embodiment of Figure **3** shared trucks **28** and **30** are double axle trucks, a person skilled in the art will appreciate that other types of trucks, such as three axle trucks, could be used instead.

[0083] Intermediate unit **24** has a first end structure **52** supported by shared truck **28** and a second end structure **54** supported by shared truck **30**. Intermediate unit **24** includes a body **56** having a pair of deep, spaced apart side beams **58** and **60** extending between, and mounted to, end structures **52** and **54**. A well **62** for receiving one or more cargo containers is defined longitudinally between end structures **52** and **54**. Side beams **58** and **60** define the sides of well **62**. End structure **52** has a stub sill **64** mounted over shared truck **28** and extending to articulation connection **36**. Similarly, at the other end of intermediate unit **24**, a

stub sill **66** is mounted over shared truck **30** and extends to articulated connection **38**.

[0084] End unit **22** has substantially the same structure as intermediate unit **24** described above, but has an articulated connection at one end only. More specifically, end unit **22** has a first end structure **68** supported by end car truck **32** and a second end structure **70** supported by shared truck **28**. Each end structure **68**, **70** has a stub sill **72**, **74**. Stub sill **72** is mounted above shared truck **28** and extends to articulated connection **36**. At its distal end stub sill **74** has a standard releasable coupler **76** mounted thereto to allow end unit **22** to be coupled and uncoupled when forming a new train consist. Coupler **76** is of the type to allow interchangeable service with rail road freight cars in general service in North America. End unit **26** is substantially the same as end unit **22** described above. As shown in Figure **1**, its first and second end structures are identified as **78** and **80**, respectively. First end structure **78** is supported on shared truck **30**. Second end structure **80** has a standard releasable coupler **76** mounted thereto.

[0085] Articulated connections **36** and **38** (and the other articulated connections noted herein) are preferably steel articulated connectors, indicated generally in Figure **2** as **82** and **84**, respectively, similar to those commonly available from manufacturers such as Westinghouse Air Brake (WABCO) of Wilmerding Pa., or American Steel Foundries (ASF), also known as Amsted Industries Inc., of Chicago Il. The general form of one type of articulated connector (with a vertical pin) is shown, for example, in U.S. Patent 4,336,758 of Radwill, issued June 29, 1982. In general, this kind of permanent, articulated connection has a female articulated connector portion, in the nature of a female socket **86** mounted to the end structure of one articulated rail car unit (in the case of articulated connector **82**, end structure **52** of intermediate unit **24**), and a male articulated connector portion or member **88** mounted to the end structure of an adjacent rail car unit, (in the case of articulated connector **82**, end structure **70** of end unit **22**), as shown in Figures **3** and **5**. Female socket **86** of articulated connector **82** or **84** rests in, and is supported by, truck center plate **40** of shared truck **28** or **30**, as the case may be.

[0086] A conceptual illustration of articulated connector **82** (and **84**) is shown in cross-section in Figure **5**. Figure **5** is not necessarily to scale, and may not show all of the features of articulated connector **82** or **84** in detail. Male member **88** has an extension, or nose, **90** that seats in female socket **86**. A main pivot pin **92** extends through a bore defined in top plate **94** of female socket **86**, through a bore, or passage **96** in male member **88**, and through the base plate **98** of female socket **86**. Pivot pin **92** is nominally vertical. That is, on straight, level track pin **92** is vertical. Pivot pin **92** acts as a locking pin to prevent female socket **86** and male member **88** from separating from each other. The mated portions **86** and **88** of the articulated connector

are joined to shared truck **28** or **30**, by way of a pin (not shown) which extends from blind bore **102** of pin **92** to seat in a central bore (not shown) defined in truck center plate **48**. With specific reference to articulated connector **82**, the truck center plate **48** of shared truck **28**, supports the portion of the weight of intermediate unit **24** that is transferred through female socket **86** mounted thereto, and the portion of the weight of end unit **22** that is transferred through male member **88** associated therewith.

[0087] Male member **88** has three rotational degrees of freedom relative to female socket **86** to accommodate curvature, dips and rises in the track over which the rail road car **20** may travel. First, it can yaw about the main pivot axis, as when the car units negotiate a bend or switch. Second, it can pitch about a transverse horizontal axis, as when the car units change slope at the trough of a valley or the crest of a grade. Third, the car units can roll relative to each other, as when entering or leaving super-elevated cross-level track, (that is, banked track). It is not intended that male member **88** have any translational degrees of freedom relative to female socket **86**, such that a vertically downward shear load can be transferred from male member **88** into female socket **86**, with little or no longitudinal or lateral play. To permit these motions, female socket **86** has spherical seat **106** having an upwardly facing bearing surface describing a portion of a spherical surface. Another mating spherical annular member **108** sits atop seat **106**, and has a mating, downwardly facing, bearing surface describing a portion of a sphere such that a spherical bearing surface interface is created. Member **108** also has an upwardly facing surface upon which male member **88** sits. An insert **110** has a cylindrical interface lying against pin **92**, and a spherical surface that engages a mating spherical surface of passage **96** lying on the inside face of nose **90**. A wedge **112** and wear plate **114** are located between nose **90** and the inner wall, or groin, **116**, of female socket **86**. Wear plate **114** has a vertical face bearing against wedge **112**, and a spherical face bearing against a mating external spherical face of nose **90**. Wedge **112** bears against wear plate **114**, as noted, and also has a tapered face bearing against a corresponding tapered face of groin **116**. The tapers are formed such that as wear occurs, gravity will tend to urge wedge **112** downwardly, tending to cause articulated connector **82** or **84** to be longitudinally slackless.

[0088] While in the preferred embodiment, articulated connectors **82** and **84** are of the type in which the main pin is nominally vertical, a person skilled in the art will appreciate that other types of articulated connectors may be used. For instance, articulated connectors in which the main pin is nominally horizontal such as shown in U.S. Patent 5,271,571 of Daugherty, Jr., could also be used.

[0089] In the preferred embodiment shown in Figures **2** and **3**, articulated connection **36**

is formed with the female socket **80** of articulated connector **82** being mounted to intermediate unit **24** and male member **88** being mounted to end unit **22**. Articulated connected **38** is configured in like fashion. Female socket **86** of articulated connector **82** is mounted to intermediate unit **24** and male member **88** is attached to end unit **26**. In this way, end structures **52** and **54** of intermediate unit **24** possess identical female articulated connector portions **86**. Stated another way, the articulated connector portions of intermediate unit **24** are symmetrical about the mid-span centerline of intermediate unit **24** (indicated in Figure **2** as 'CL - Transverse'). Correspondingly, the articulated connector portions associated with end units **22** and **26** are mirror images one of the other.

[0090] While in the preferred embodiment intermediate unit **24** of rail road car **20** is provided with a pair of identical female articulated connector portions **86**, symmetry in the articulated connector arrangement may be achieved differently. In an alternative embodiment shown in Figure **6**, a three-unit rail road car **118** has a middle or intermediate unit **120** and first and second end units **122** and **124**, respectively. Middle unit **120** has identical male articulated connector portions **88** mounted to either end for mating with female articulated connector portions **86** associated with the adjacent ends of each of end units **122** and **124**. As in the preferred embodiment of Figures **4a** and **4b**, the arrangement of articulated connectors about the mid-span centerline of the intermediate unit (in this case, middle unit **120**) is symmetrical.

[0091] In the embodiments described, the symmetrical arrangement of articulated connector portions on intermediate units **24** and **120** may tend to avoid disadvantages associated with the asymmetric arrangements of articulated connector portions. More specifically, the dynamic performance of rail road cars **20** and **118** on the track may tend to be improved generally. The stability of intermediate units **24** and **120** may tend to be enhanced. Moreover, rail road cars **20** and **118** may tend to exhibit similar ride performance characteristics in both directions of travel with comparable L/V values for the truck wheels **47**.

[0092] Arranging the articulated connector portions as shown in the embodiments of Figures **2** and **6** may also tend to yield efficiencies in manufacturing, thereby reducing costs. More specifically, by providing intermediate unit **24** and **120** with identical articulated connector portions the number of different sub-assemblies required to fabricate these units is reduced. Furthermore, since in the embodiments of Figures **2** and **6**, both end units **22** and **26**, and **122** and **124** have identical articulated connector portions, fabrication of one end unit, for instance end unit **22**, is generally the same as that of the other, for instance, end unit **26**. In a conventional three-unit rail road car, by reason of the asymmetric arrangement of articulated connector portions, different production steps may be required to fabricate the opposed end units - the one

end unit being fabricated with a female articulated connector portion and the other end unit having a male articulated connector portion.

[0093] In the embodiments shown in Figures **2** and **6**, the extent of "side sway" or roll of one railcar unit relative to the next adjacent railcar unit is controlled by a pair of longitudinally extending, side-bearing support arms associated with each railcar unit. While the arrangement of side-bearing arms in rail road car **20** is described below with reference to adjacent units **22** and **24**, it is understood that this description applies as well to the arrangement of side-bearing arms of adjacent units **26** and **24**, the latter arrangement being identical to the former arrangement. Accordingly, each end structure **52**, **54** of intermediate unit **24** has an identical arrangement of side-bearing arms and the side-bearing arms of end units **22** and **26** are identical to each other as shown in Figure **4a**. For reasons similar to those explained above in connection with the use of a symmetrical arrangement of articulated connector portions, employing a symmetrical arrangement of side-bearing arms may tend to be cost-effective.

[0094] With reference to Figures **4a** and **4b**, end unit **22** has a pair of side-bearing support arms **126** and **128** mounted to end structure **70**. Nested within, (that is, bracketed by) and lying laterally inboard of, side-bearing arms **126** and **128** is an opposing pair of side-bearing arms **130** and **132** associated with intermediate unit **24**. Each side-bearing arm **126** and **128** is spaced laterally away from, and splayed slightly outwardly of, male portion **86** of articulated connector **36**. Side-bearing arms **126** and **128** are laterally spaced from each other a distance $\mathbf{D_1}$ measured center-to-center at the proximal ends of the side-bearing arms. Side bearing arms **130** and **132** extend substantially perpendicular of end structure **52** and are laterally spaced from each other a distance $\mathbf{D_2}$. Distance $\mathbf{D_2}$ is the distance measured center-to center at the proximal ends of the side-bearing arms. In this embodiment, distance $\mathbf{D_1}$ is greater than distance $\mathbf{D_2}$. In the preferred embodiment of Figures **4a** and **4b**, distance $\mathbf{D_1}$ is 60 inches. However, $\mathbf{D_1}$ may be and is advantageously between 56 and 64 inches. Distance $\mathbf{D_2}$ is at least about 42 inches. In the preferred embodiment shown in Figures **4a** and **4b**, and subject to the value of $\mathbf{D_1}$, Distance $\mathbf{D_2}$ may be in the range of 36 to 46 inches, and is preferably about 42 inches. It is possible to modify the spacing of each pair of side-bearing arms while still maintaining the nested relationship between the wide pair of side-bearing arms **126** and **128** and the relatively narrower pair of side-bearing arms **130** and **132**. For instance, in one alternative configuration, $\mathbf{D_1}$ may be about 52 inches and $\mathbf{D_2}$ may be about 48 inches. However, the range of values for distances $\mathbf{D_1}$ and $\mathbf{D_2}$ is constrained by certain design parameters, such as, the overall width of the rail car unit and clearance from the articulated connector.

[0095] Each side-bearing arm **126**, **128**, **130** and **132** is supported by a respective side

bearing interface in the nature of a local bearing pedestal having a bearing surface **134** mounted atop truck bolster **40** on each side of truck center plate **48**. A side bearing **136** mounted beneath each side-bearing arm **126**, **128**, **130** and **132** permits a portion of the weight of intermediate unit **22** or **24**, as the case may be, to be transferred from the given side-bearing arm through side bearing **136** and side bearing interface **134**, to shared truck **28**. In addition, side bearings **136** tend to lessen resistance to the movement of the side-bearing arms relative to side bearing interface **134**. Side bearings **136** may be constant contact side bearings with or without rollers. However, preferably, side bearings **136** are 5000XT-SSB extended travel, constant contact, roller-less, side bearings manufactured by and available from A. Stucki Company of Pittsburgh, Pennsylvania. The use of these side bearings may tend to reduce the forces to which the side-bearing arms are subjected and may tend to contribute to a reduction in the L/V values of the truck wheels.

[0096] In Figure **3**, side-bearing arms **126**, **128**, **130** and **132** are shown mounted at a height **H** with their respective side bearing interfaces **134** lying slightly above the horizontal plane that (when the car units are sitting on straight, level track) passes through the center of curvature of the spherical surfaces of the articulated connector. In the preferred embodiment, **H** is approximately 37 inches above TOR. However, it will be appreciated that the bearing interfaces of the side-bearing arms may be carried at a different height in the range of 36 to 48, or more inches above TOR. In one embodiment, the height H is about 44 inches above TOR.

[0097] It has been shown that the forces generated in the side-bearing arms of a three-unit railroad car provided with a symmetrical arrangement of articulated connector portions, tend to be smaller than the forces acting on the side-bearing arms of conventional three-unit railroad cars employing asymmetric articulated connection arrangements. This reduction of the forces in the side-bearing arms may tend to reduce vibration in the car and in so doing may tend to discourage fatigue failure and extend the service life of the car.

[0098] Forces in the side-bearing arms may also tend to be reduced by having the wide pair of side-bearing arms associated with a rail car unit having a male articulated connector portion and correspondingly, the opposing, relatively narrower, pair of side-bearing arms associated with an adjacent rail car unit having a female articulated connector portion. A further advantage of this arrangement is that it may tend to contribute to a reduction in L/V values for the truck wheels. While in the preferred embodiment of Figures **4a** and **4b**, these advantages may be realised by having the wide pair of side-bearing arms associated with end unit **22**, it will be appreciated that different arrangements may be used. In the alternative embodiment shown in Figure **6**, the wide pair of side-bearing arms **119** is mounted to intermediate unit **120** which has

male articulated connector portion **88**. In that embodiment, end unit **122** has female articulated connector portion **86**, and the relatively, narrower pair of side-bearing arms **121**.

[0099] While it is preferred that the wide pair of side-bearing arms be mounted to a rail car unit having a male articulated connector portion and the relatively narrower pair of side-bearing arms mounted to an adjacent rail car unit having a female articulated connector portion, the arrangement of the wide pair and the narrow pair of side-bearing arms may be reversed. Figure **7a**, shows two adjacent railcar units **138** and **140** of a three-unit articulated railroad car. Railcar unit **138** is an end unit generally similar to end unit **22** and railcar unit **140** is an intermediate unit generally similar to intermediate unit **24**. In this embodiment, a narrow pair of side-bearing arms **142** and **144** is mounted to the end of end unit **138** also having male articulated connector portion **88** mounted thereto. A pair of relatively wider side-bearing arms **146** and **148** is mounted to the end of intermediate unit **140** also having female articulated connector portion **86** mounted thereto. Side-bearing arms **142** and **144** are nested within, that is, lie between, side-bearing arms **146** and **148**. The lateral spacing of the side-bearing arms **146** and **148** (measured center-to center at the proximal ends thereof) may be as great as 70 inches. The lateral spacing of side-bearing arms **142** and **144** (measured center-to center at the proximal ends thereof) is at least 42 inches. In this embodiment, the wide side-bearing arms **146** and **148** are associated with the railcar unit (in this case, intermediate unit **140**) having the female articulated connector portion **86** instead of the male articulated connector portion **88**.

[0100] In the embodiments shown and described above, the opposed pairs of side-bearing arms are in a nested arrangement. However, other alternative side-bearing arm arrangements may also be used. For instance, it is possible to have opposed pairs of equally laterally spaced, side-bearing arms mounted on the adjacent ends of the railcar units. Figure **7b** shows two adjacent railcar units **150** and **152** of a three-unit articulated railroad car. Railcar unit **150** is an end unit generally similar to end unit **22**, and railcar unit **152** is an intermediate unit generally similar to intermediate unit **24**. The adjacent ends of railcar units **150** and **152** each have a pair of side-bearing arms **154**, **156** and **158**, **160**, respectively. Each pair of side-bearing arm **154**, **156** and **158**, **160** is mounted to extend substantially perpendicular to its respective rail car unit end. As shown in Figure **7b**, the lateral spacing of side-bearing arms **154** and **156** is the same as that between side-bearing arms **158** and **160** such that the distal ends of the former pair of side-bearing arms are longitudinally aligned with the distal ends of the latter pair of side-bearing arms. The lateral spacing side-bearing arms (measured center-to center at the proximal ends thereof) may be in the range of about 50 inches to about 70 inches. In the embodiment of Figure **7b**, the lateral spacing is 50 inches.

[0101] In an another alternative arrangement of side-bearing arms, opposing pairs of equally laterally spaced, diverging side-bearing arms may be employed. Referring to Figure **7c**, adjacent railcar units **162** and **164**, generally similar to units **22** and **24**, respectively, each have a pair of side-bearing arms **166**, **168** and **170**, **172**. Side-bearing arms **166**, **168** are outwardly splayed (i.e. diverge from each other). Side-bearing arms **170** and **172** are similarly configured. In this embodiment, the distal ends of diverging side-bearing arms **166** and **168** are longitudinally aligned with the distal ends of the opposing, diverging side-bearing arms **170** and **172**. In a modification of this alternative embodiment, a pair of diverging side bearing-arms may be arranged in laterally staggered relation to an opposing pair of diverging bearing-arms. Figure **7d**, shows a railcar unit **174** having a pair of diverging side-bearing arms **176** and **178** and an adjacent railcar unit **180** having an opposing pair of diverging side-bearing arms **182** and **184**. The lateral spacing between side-bearing arms **176** and **178** (as measured between the proximal ends thereof) is slightly less than the lateral spacing between side-bearing arms **182** and **184** such that the distal ends of side-bearing arms **176** and **178** are staggered or offset laterally inboard from the distal ends of the side-bearing arms **182** and **184**.

[0102] In an alternative embodiment, the opposing pairs of side-bearing arms associated with adjacent rail car units may be mutually engaging in a male-female relationship. Figures **7e** and **7f**, show adjacent rail car units **185** and **186**. Rail car unit **185** has a pair of female side-bearing arms **187** and **188** mounted thereto. Each female side-bearing arm **187**, **188** terminates in an inverted, generally U-shaped distal end **190**. Distal end **190** forms a channel **191** having a back **192** from which depends a pair of spaced-apart flanges **193** and **194**. Back **192** includes a downwardly facing bearing surface **195**. A space is defined between flanges **193** and **194** for accommodating an opposing pair of male side-bearing arms **196** and **197** of rail car unit **186**. Arranged in this manner, the male side-bearing arms **196** and **197** fit within the female side-bearing arms **187** and **188**.

[0103] Each male side-bearing arm **196**, **197** has an upwardly facing bearing surface **198** located opposite downwardly facing bearing surface **195** of female side-bearing arms **187** and **188**. A wear pad **203** is located between bearing surfaces **195** and **198** of each male-female pairing of side-bearing arms **187**, **196**, and **188**, **197**. In a modification to this arrangement, it would be possible to reverse the orientation of the male and female bearing surfaces such that the bearing surface of female side-bearing arms are upwardly facing and correspondingly, the bearing surface of male side-bearing arms are downwardly facing.

[0104] A three-unit articulated rail road car may be constructed using any of the various alternative arrangements of side-bearing arms described and shown in Figures **7b** to **7f**, whether

the intermediate unit is provided with identical female articulated connector portions (as in the preferred embodiment of Figures **4a** and **4b**) or identical male articulated connector portions (as in the embodiment of Figure **6**).

Five-Unit Articulated Rail Road Car

[0105] Figures **8a** to **8c** show a five-unit articulated rail road car **204**. Car **204** has two end units **206** and **208**, and three intermediate units **210**, **212** and **214** connected therebetween. Unit **212** is the centre unit. The various units **206**, **210**, **212**, **214** and **208** are joined end-to-end by articulated connectors **216**, **218**, **220** and **222**. Each articulated connector **216**, **218**, **219**, **222** is supported on a respective shared truck **224**, **226**, **228**, **230**.

[0106] Car **204** is symmetrical about the mid-span centerline of center unit **212** (indicated in Figure **8b** as 'CL - Transverse') such that intermediate units **210** and **214** are mirror images one of the other, as are end units **206** and **208**. Accordingly, for the sake of brevity it will suffice to describe the arrangement of units **206**, **210** and **212**.

[0107] Center unit **212** has mounted at each end a female articulated connector portion **86** and a relatively wide pair of side-bearing arms **232** and **234** for locating in a nested arrangement with narrower side-bearing arms **236** and **238** of the respective adjacent intermediate unit **210** or **214**, as the case may be. Intermediate unit **210** has a conventional asymmetric arrangement of articulated connector portions. Intermediate unit **210** has a male articulated connector portion **88** at the end adjacent center unit **212** and a female articulated connector portion **86** at the opposite end thereof. A pair of side bearing arms **240** and **242** identical to side bearing arms **236** and **238** is mounted to the end of intermediate unit **210** adjacent end unit **206** such that intermediate unit **210** has a symmetrical arrangement of side-bearing arms. End unit **206** is generally similar to end unit **22**, but differs in that it has a wide pair of side-bearing arms **244** and **246** for locating in a nested arrangement with narrower side-bearing arms **240** and **242** of intermediate unit **210**.

[0108] In the embodiment shown in Figures **8a** to **8c**, center unit **212** has identical female articulated connector portions **86** at both ends thereof; intermediate unit **214** has an asymmetrical arrangement of articulated connector portions, namely a male connector portion **88** at one end to mate with center unit **212**, and a female connector portion **86** at the opposite end thereof; and end unit **206** is provided with a male articulated connector portion **88**. In an alternate rail road car to that of car **204**, the articulated connector portions associated with each railcar unit may be changed from male to female, or female to male, as the case may be.

[0109] Figures **10a** and **10b** show a five-unit articulated railroad car **248** similar in construction to car **204**. Car **248** has two end units **250** and **252** and three intermediate units

254, **256** and **258**, with unit **256** as the center unit. Similar to car **204**, car **248** is symmetrical about the mid-span centerline of center unit **256** (indicated in Figure **10a** as 'CL - Transverse'). However, in this embodiment, center unit **256** is provided with female articulated connector portions **86** at both ends. Intermediate unit **254** has male articulated connector portions **88** at both ends, such that the end adjacent center unit **256** has a male articulated connector portion **88** and the opposite end thereof also has male articulated connector portion **88** adjacent to end unit **250**. Correspondingly, end unit **250** has a female articulated connector portion **86**. As shown in Figure **10b**, the arrangement of side-bearing arms on car **248** is the same as on car **204**.

[0110] Other variations to the articulated connection arrangements in a five-unit articulated rail road car are possible. For instance, in cars **204** and **260**, only center units **212** and **268** have identical articulated connector portions at each end, namely, two male connector portions **88** at the ends of unit **212**, and two female connector portions **86** at the ends of unit **268**. The other, intermediate, units **266**, **270**, each have one male connector portion and one female connector portion. In Figures **11a** and **11b**, five-unit articulated rail road car **260** has two end units **262** and **264**, and three intermediate units **266**, **268** and **270**. Intermediate unit **268** is the centre unit. Car **260** is similar to car **204** in that it is also symmetrical about the mid-span centerline of center unit **268** (indicated in Figure **11a** as 'CL - Transverse'). In this embodiment, center unit **268** has two male articulated connector portions **88** and intermediate neighbouring units **266 and 270** have two female articulated connector portions **86** adjoining unit **268**, and male connector portions **88** adjoining unit **262**, or **264**, as may be. Correspondingly, end unit **262** has a female articulated connector portion **86**. As shown in Figure **11b**, the arrangement of side-bearing arms on car **260** is the same as on car **204**.

[0111] Alternatively, a similar arrangement to that of car **248** may be achieved by changing the articulated connector portions associated with each railcar unit from male to female, or female to male, as the case may be. With reference to Figures **12a** and **12b**, a five-unit articulated rail road car **272** has two end units **274** and **276** and three intermediate units **278**, **280** and **282** with intermediate unit **280** as the centre unit. In this embodiment, centre unit **280** has male articulated connector portions **88** at both ends and intermediate units **278**, **282** have female articulated connector portions **86** at both ends. Correspondingly, a male articulated connector portion is mounted to the end of end unit **274** (or **284**, as may be) adjacent intermediate unit **278** (or **282**, as may be). As shown in Figure **12b**, the arrangement of side-bearing arms on car **272** is the same as on car **204**.

[0112] In the embodiment shown in Figures **8a** to **8c**, intermediate unit **210** has narrow pairs of side-bearing arms **236**, **238** and **240**, **242** mounted at opposite ends for locating in a nested arrangement with relatively wider pairs of side-bearing arms **232**, **234** (of centre unit **212**) and **244**, **246** (of end unit **206**), respectively. However, alternate arrangements of side-

bearing arms may also be possible. For instance, different arrangements of nested side-bearing arms may be employed. Alternatively, arrangements having equally laterally spaced, opposing pairs of side-bearing arms could be used. In the further alternative, a five-unit articulated rail road car could use a combination of nested side-bearing arms and equally laterally spaced opposing side-bearing arm arrangements.

[0113] Referring to Figure **9a**, a five-unit articulated rail road car **290** has two end units **292** and **294**, and three intermediate units **296**, **298** and **300** with unit **298** as the center unit. Car **290** is symmetrical about the mid-span centerline of center unit **298** (indicated in Figure **9a** as 'CL - Transverse'). Center unit **298** is substantially identical to center unit **212** described above and shown in Figure **8b**, with identical pairs of side-bearing arms **302** and **304** mounted at each end thereof. Intermediate unit **296** has a narrow pair of side-bearing arms **306** and **308** mounted at an end thereof adjacent center unit **298** and a relatively wide pair of side-bearing arms **310** and **312** mounted at the opposite end. Side-bearing arms **306** and **308** nest within the wider pair of side-bearing arms **302** and **304** associated with the adjacent end of center unit **298**. End unit **292** is similar in construction to end unit **206** described above but differs in that it has a relatively, narrower pair of side-bearing arms **314** and **316** for locating in a nested arrangement with the opposing wide pair of side-bearing arms **310** and **312** of intermediate unit **306**.

[0114] Figure **9b** shows an alternate five-unit articulated rail road car **318** having two end units **320** and **322**, and three intermediate units **324**, **326** and **328** with unit **326** as the center unit. Car **318** is symmetrical about the mid-span centerline of center unit **326** (indicated in Figure **9b** as 'CL - Transverse'). Center unit **326** is substantially identical to center unit **212** with identical pairs of side-bearing arms **330** and **332** mounted at either end. End unit **320** is substantially identical to end unit **206** described above and shown in Figure **8b**. Intermediate unit **324** is generally similar to intermediate unit **296**, but with its side-bearing arm arrangements reversed such that at an end adjacent center unit **326**, intermediate unit **324** has a wide pair of side-bearing arms **334** and **336** while at the opposite end thereof, there is mounted a narrow pair of side-bearing arms **338** and **340**. Similar to the side-bearing arrangement shown in Figure **7d**, the distal ends of the pair of side-bearing arms **334** and **336** are longitudinally aligned with the distal ends of the opposing pair of side-bearing arms **330** and **332** associated with the center unit **326**. Narrow pair of side-bearing arms **338** and **340** are nested within an opposing wider pair of side-bearing arms **342** and **344** associated with end unit **320**.

[0115] Figure **9c** shows an another alternate five-unit articulated rail road car **346**. Car **346** has two end units **348** and **350**, and three intermediate units **352**, **354** and **356** with unit **354** as the center unit. Car **346** is symmetrical about the mid-span centerline of center unit **354** (indicated in Figure **9c** as 'CL - Transverse'). Center unit **354** is substantially identical to center unit **212** with identical pairs of side-bearing arms **358** and **360** mounted at each end thereof. End

unit **348** is identical to end unit **292** described above and shown in Figure **9a**. Intermediate unit **352** has identical, relatively wide, pairs of side-bearing arms **362** and **364** at either end. In this embodiment, at the end of intermediate unit **352** adjacent center unit **354**, the distal ends of side-bearing arms **362** and **364** are longitudinally aligned with the distal ends of the side-bearing arms **358** and **360** mounted to center unit **354**. At the opposite end of intermediate unit **354**, a relatively narrow pair of side-bearing arms **366** and **368** associated with end unit **348** nest within the wider pair of side-bearing arms **362** and **364**.

[0116] Figure **9d** shows a further alternate five-unit articulated rail road car **370**. Car **370** is generally similar to car **346** described above and shown in Figure **9c**. It has two end units **372** and **374**, and three intermediate units **376**, **378** and **380** with unit **378** as the center unit. Car **370** differs from car **346** in that its end units **372** and **374** are provided with a relatively wide pair of side-bearing arms **382** and **384**. In this embodiment, all side-bearing arm pairs are relatively wide and are arranged such that the distal ends of one pair of side-bearing arms are longitudinally aligned with the distal ends of an opposing other pair of side-bearing arms.

[0117] Figure **9e** shows yet another alternate five-unit articulated rail road car **386**. Car **386** has two end units **388** and **390**, and three intermediate units **392**, **394** and **396** with unit **394** as the center unit. Center unit **394** is substantially identical to middle unit **24** described above and shown in Figure **2**. It has identical pairs of relatively narrow side-bearing arms **398** and **400** mounted at each end. Intermediate unit **392** and end unit **388** are substantially identical to intermediate unit **324** and end unit **320** (shown in Figure **9b**), respectively. In this embodiment, each pair of side-bearing arms **398** and **400** of center unit **394** is disposed in a nested arrangement with an opposing wide pair of side-bearing arms **402** and **404** associated with each intermediate unit **392** and **396**. The side-bearing arm arrangement between adjacent ends of units **388** and **392** is similar to that described above in connection with units **320** and **324**.

[0118] Figure **9f** shows still another alternate five-unit articulated rail road car **406** having two end units **408** and **410**, and three intermediate units **412**, **414** and **416** with unit **414** as the center unit. In this embodiment, center unit **414** is substantially identical to center unit **394** with identical pairs of relatively narrow side-bearing arms **418** and **420** mounted at each end. End unit **408** and intermediate unit **412** are substantially identical to intermediate unit **348** and end unit **352** (shown in Figure **9c**), respectively. Mounted to each end of intermediate unit **412** is a pair of relatively wide side-bearing arms **422** and **424**. One pair of side-bearing arms **422** and **424** is disposed in a nested relationship with the narrow pair of side-bearing arms **418** and **420** of center unit **414**, while the other pair of side-bearing arms **422** and **424** is disposed in a nested relationship with a narrow pair of side-bearing arms **426** and **428** associated with end unit **408**.

[0119] The embodiments of Figures **9b**, **9c** and **9d** include side-bearing arrangements in

which the distal ends of one pair of side-bearing arms are longitudinally aligned with the distal ends of another opposing pair of side-bearing arms in much the same manner as the side-bearing arm arrangement shown in Figure **7b**. Those side-bearing arm arrangements may be substituted for other side-bearing arrangements having opposing pairs of equally laterally spaced side-bearing arms, such as those shown in Figures **7c**, **7e** and **7f** and described above. Alternatively, an arrangement of laterally staggered side-bearing arms such as shown in Figure **7d** may also be employed.

[0120] While various alternative side-bearing arm arrangements have been described for railroad cars possessing a configuration of articulated connections similar to that of car **204**, these side-bearing arm arrangements may also be employed in cars having different articulated connection configurations. Figures **10c** to **10h** show various side-bearing arm arrangements in railroad cars **440**, **442**, **444**, **446**, **448** and **450** having articulated connections substantially identical to those of car **218**. Figures **11c** to **11h** show various side-bearing arm arrangements in railroad cars **460**, **462**, **464**, **466**, **468** and **470** having articulated connections substantially identical to those of car **330**. Figures **12c** to **12h** show various side-bearing arm arrangements in railroad cars **470**, **472**, **474**, **476**, **478** and **480** having articulated connections substantially identical to those of car **282**.

[0121] While various three-unit and five-unit articulated rail road car embodiments have been described in detail, it will be appreciated that other multi-unit articulated rail road cars having a larger number of rail car units can be assembled from the various types of rail car units described above.

[0122] Various modifications, variations and changes may be made to the embodiments of the invention described above without departing from the nature, spirit or scope of the invention. The invention is not to be limited to those specific embodiments.